TIME-RESOLVED MORPHOLOGY OF ENDOTHELIAL CELLS IN REGIONS OF FLOW SEPARATION

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The time history of vascular endothelial cell morphology in regions of flow separation was studied. At different locations relative to the reattachment point bounding the separated region, cell alignment, cell division, and cell migration were present after 48 hours of exposure to shear stresses in the physiological range (12 to 35 dynes/cm^2).

Bovine aortic endothelial cells were grown on glass coverslips and placed in a cone-and-plate flow chamber [1,2] for times up to 48 hours. The separated flow region was created by placing a rectangular strip upstream of the region of interest. Flow detachment formed a triangular separation region extending 4 strip heights downstream. The shear stress was zero and the shear stress gradient was maximum at the reattachment point at the downstream end of the separated region. Cell density was measured relative to control cells left in a static growth chamber with the same medium [2]. Bromodeoxyuridine stain identified DNA synthesis associated with cell division.

Cells at the reattachment point (maximum shear gradient) showed commitment to cell division (up to 25% of the cells) by 4 hours, with the region affected increasing with time. These results are consistent with our postulate that a differential shear force between endothelial cells can cause cell division. After 48 hours, the cell density inside the separated region was significantly reduced from the control level whereas an increase in cell density occurred just downstream of the region of shear gradients. A comparison between the regions of enhanced cell division and enhanced cell density proved that cell migration occurred out of the reattachment region in the downstream direction. Cell alignment with the flow direction was observed outside of the region of large shear gradients, both inside the recirculation region as well as downstream of reattachment.

Research supported by The National Institutes of Health and the Johnson and Johnson Research Fund. [1] S.R. Bussolari *et al* **Rev. Sci. Inst. 53**, 1851 (1982); [2] N. DePaola, Ph.D. Thesis, MIT, 1991.

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